What Doesn't Kill You Makes You Richer: Adult Wages and the Early-Life Disease Environment in India

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Big Question

- what is the effect of early-childhood environment (nutrition, health, disease, socio-economic status) on adult outcomes (health, education, wages)?
    - this question is at the heart of a large literature, increasingly focussing on developing countries

Literature Overview

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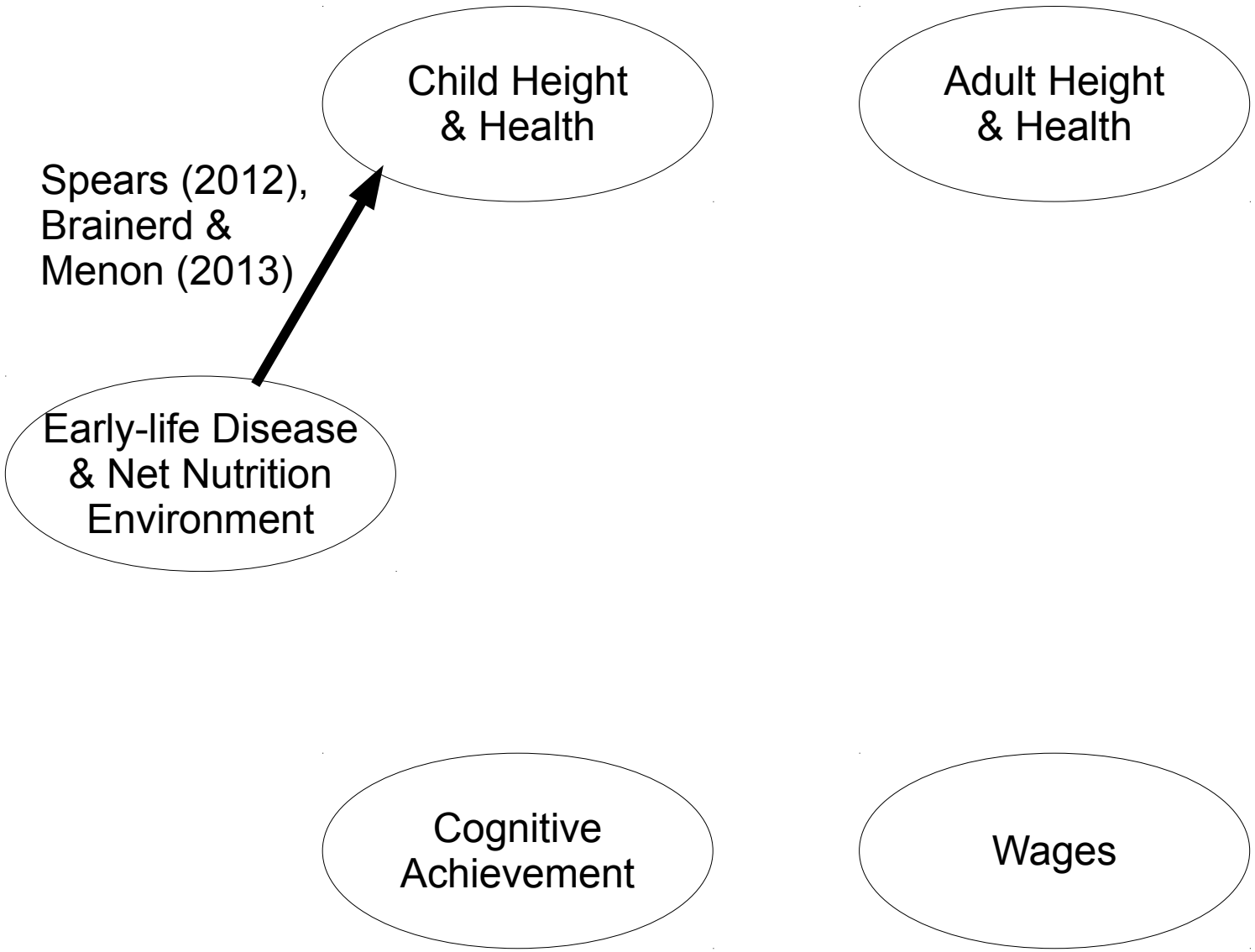

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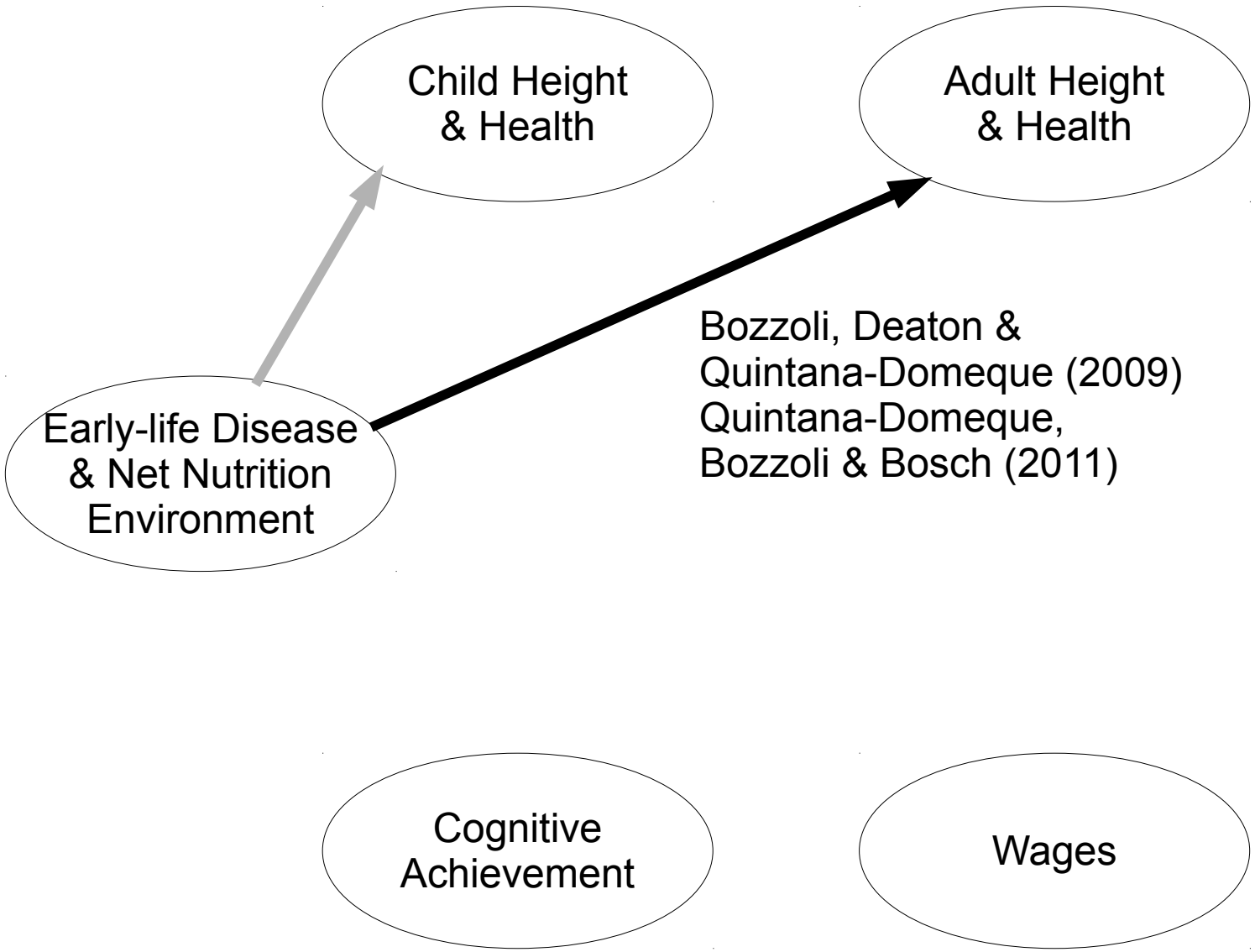

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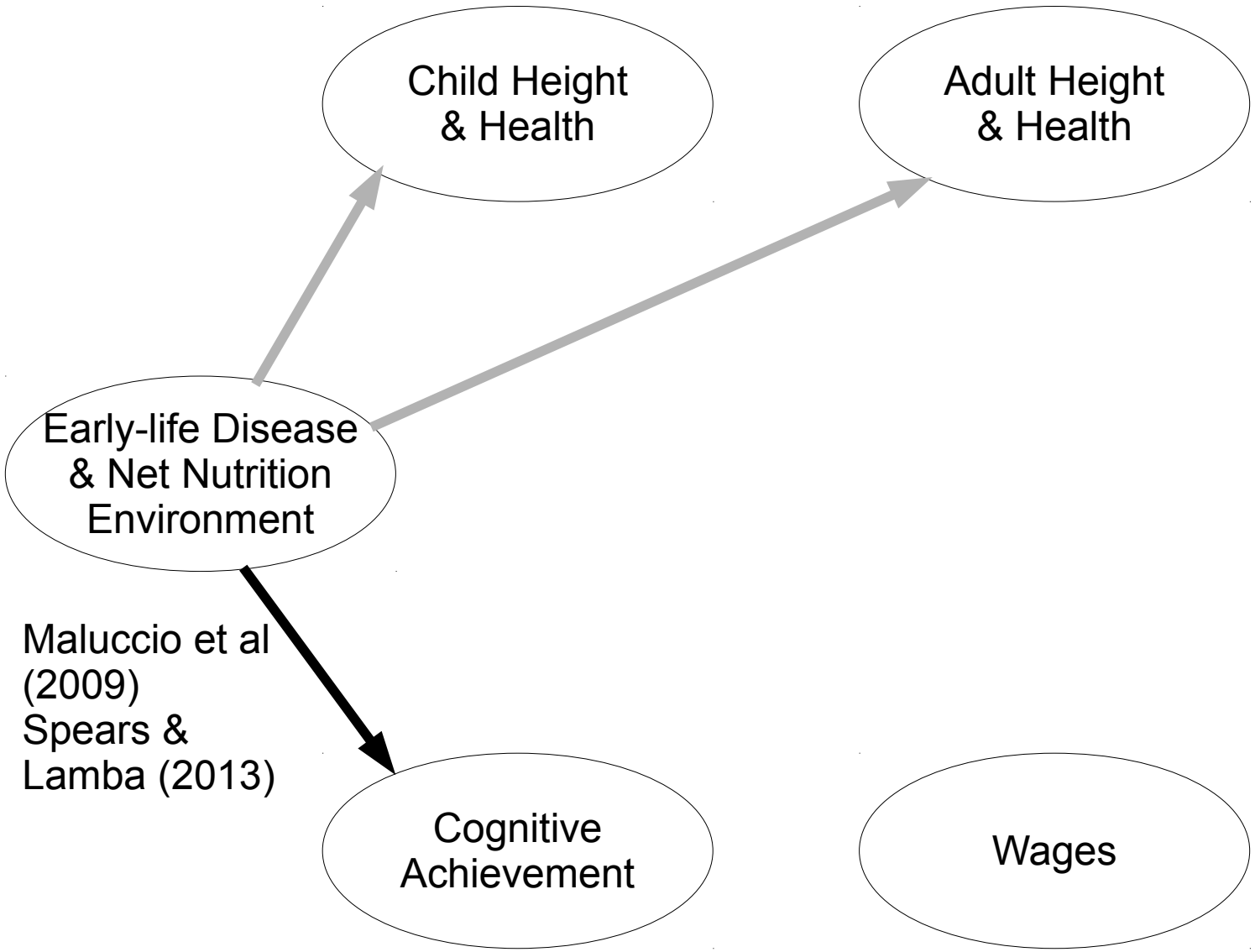

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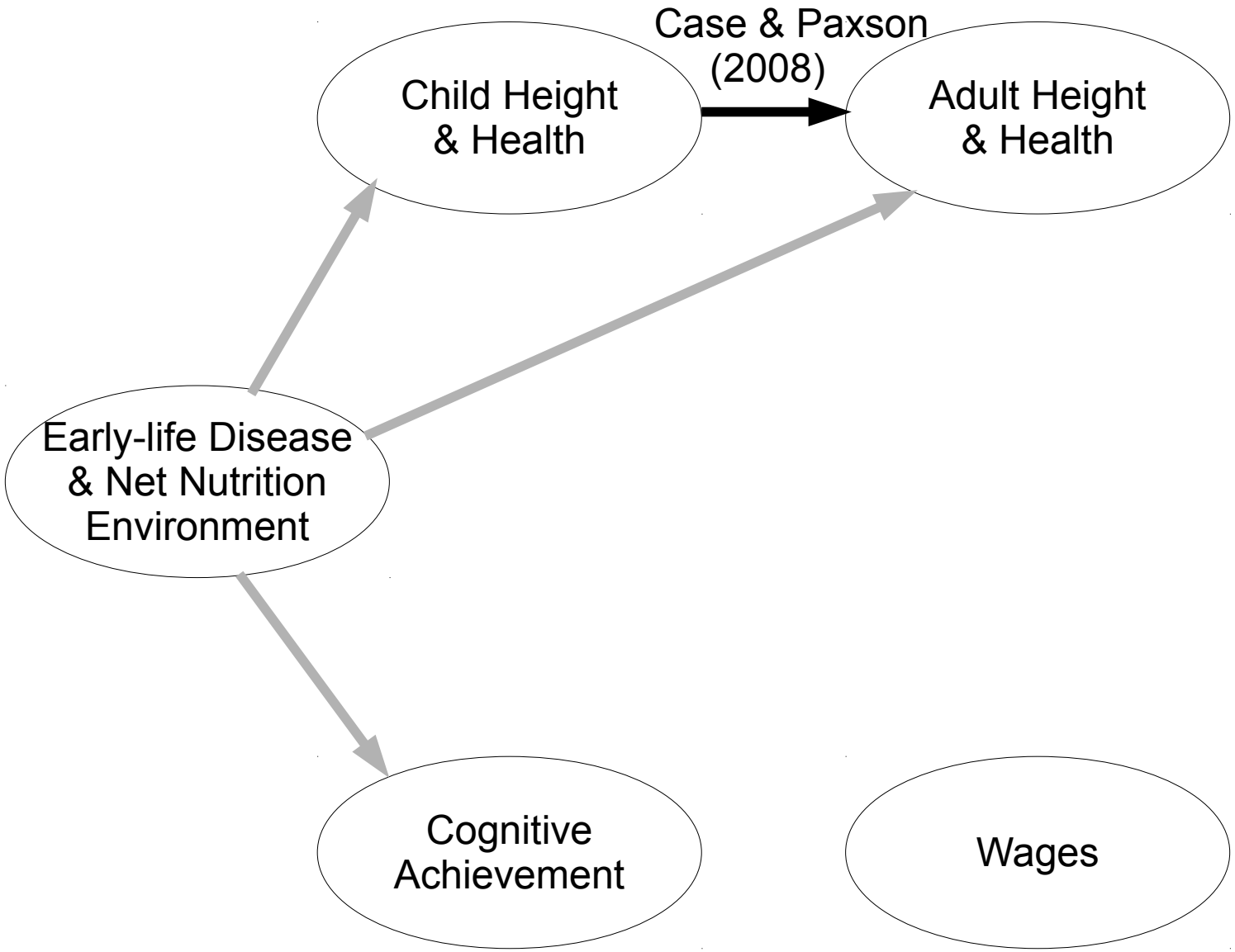

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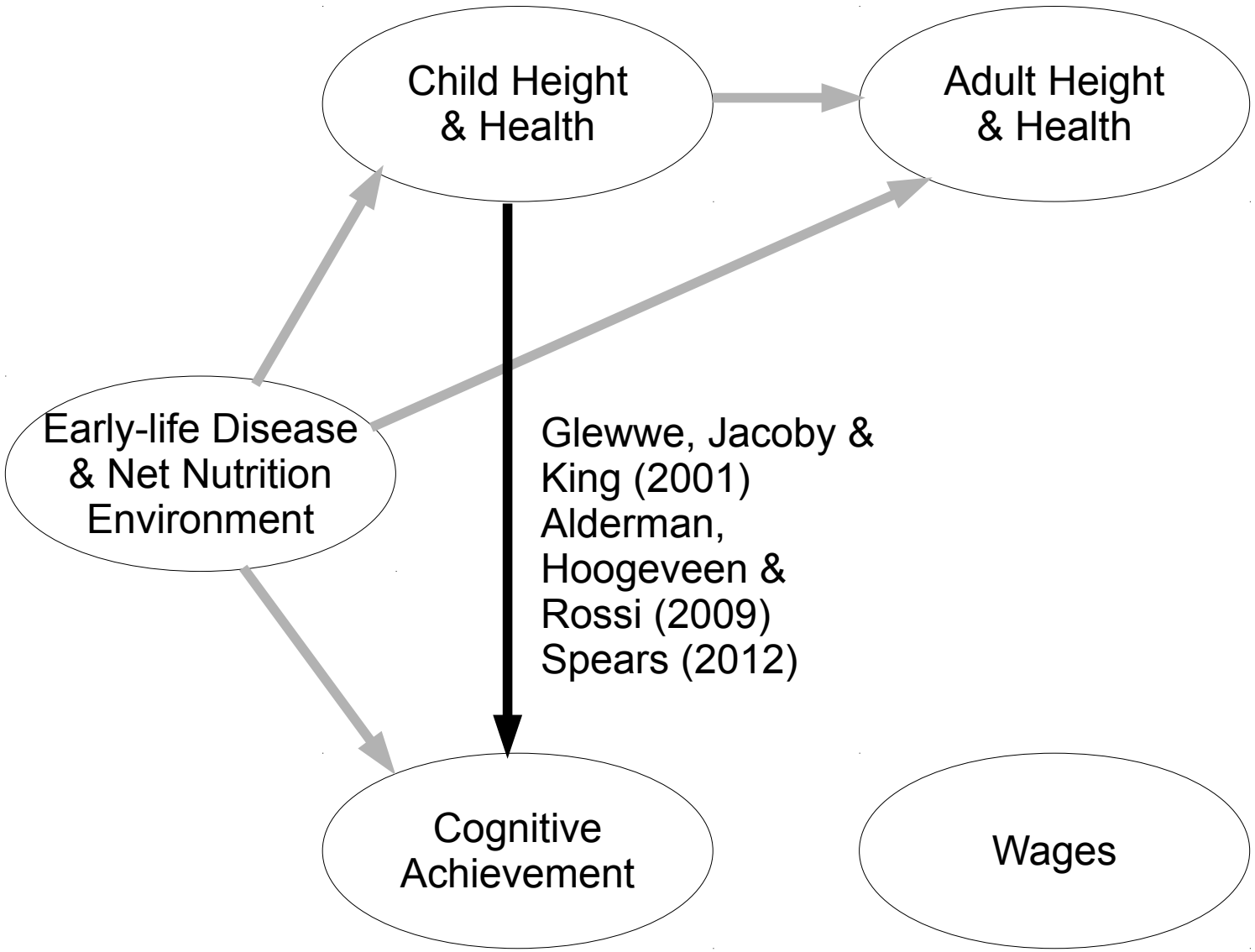

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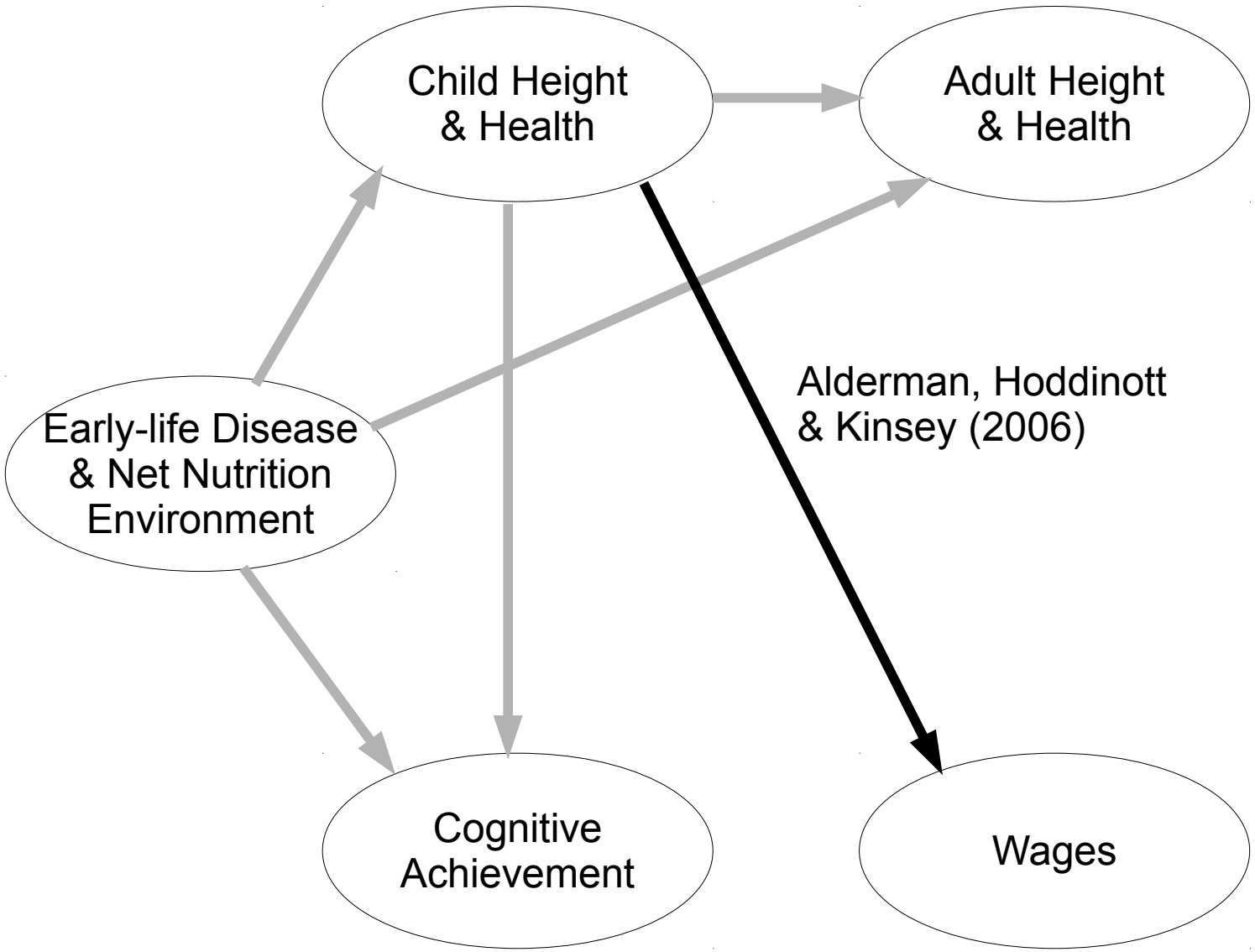

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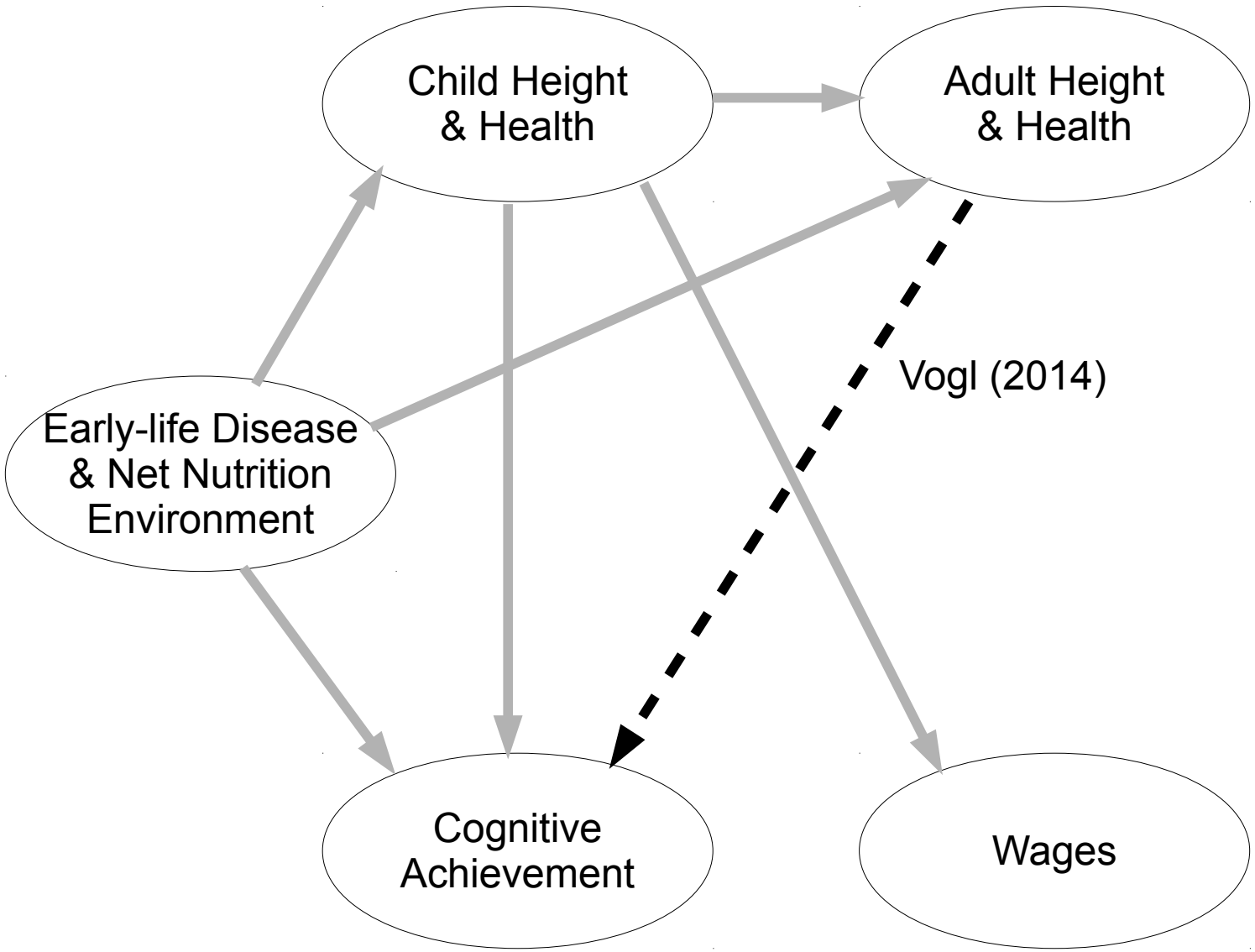

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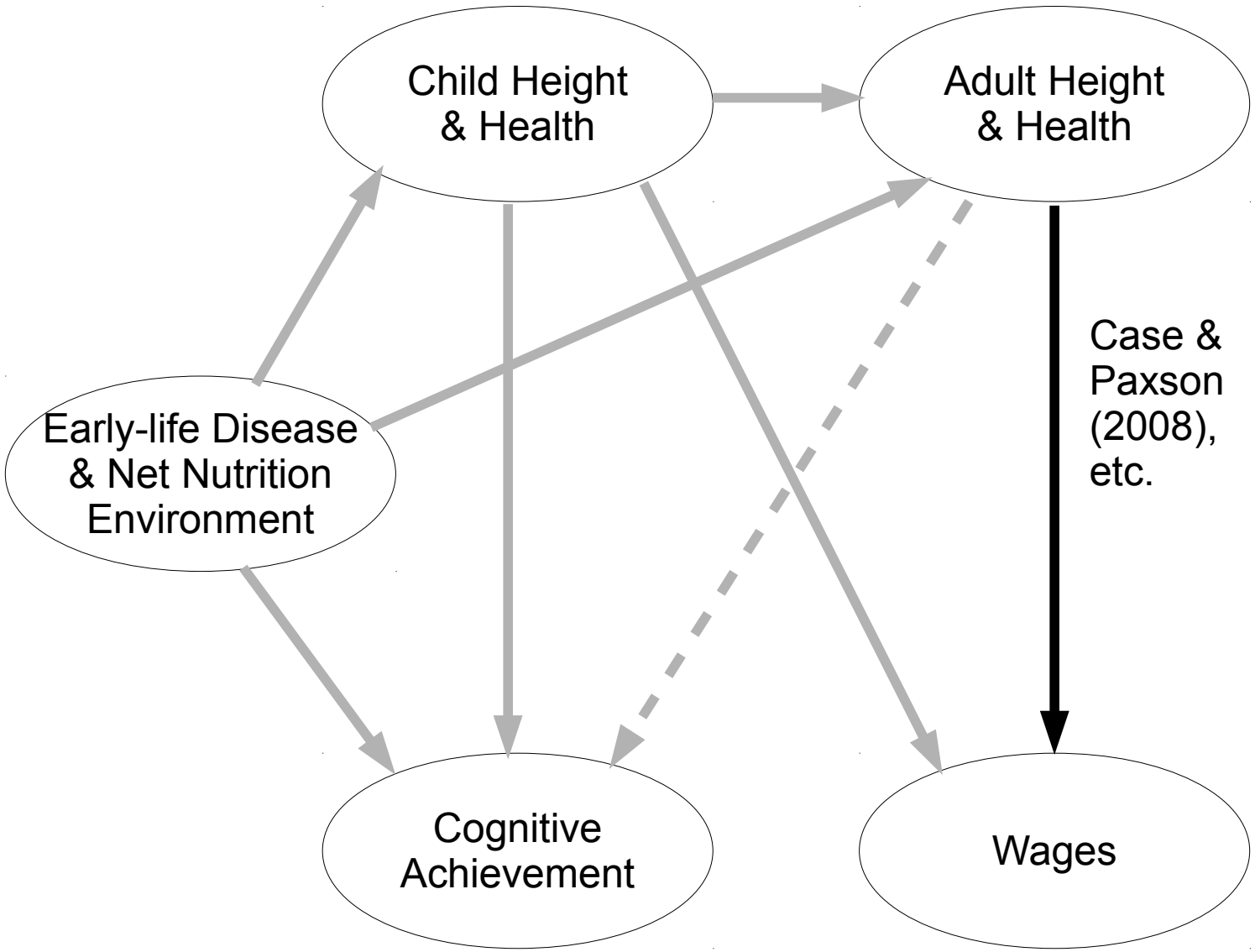

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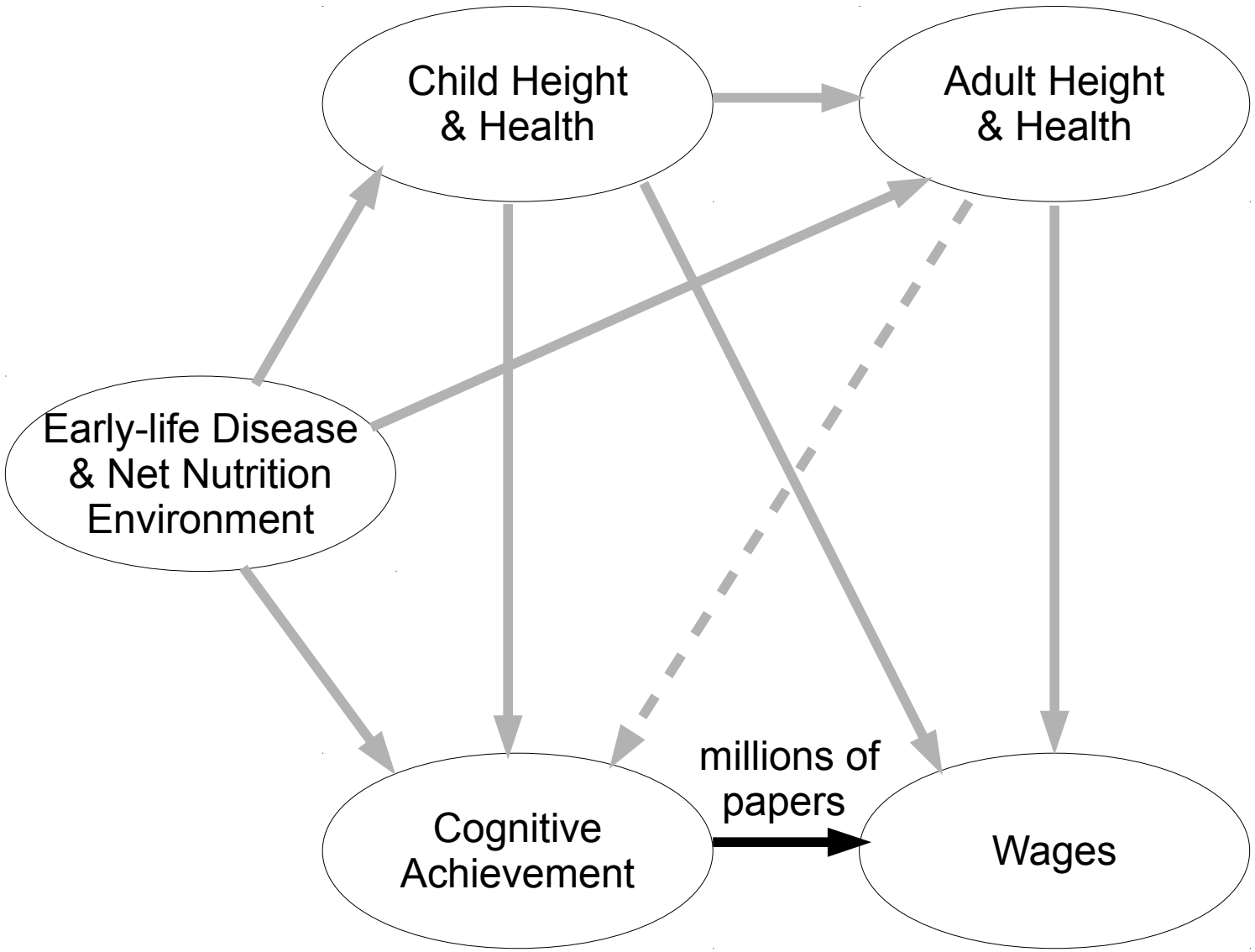

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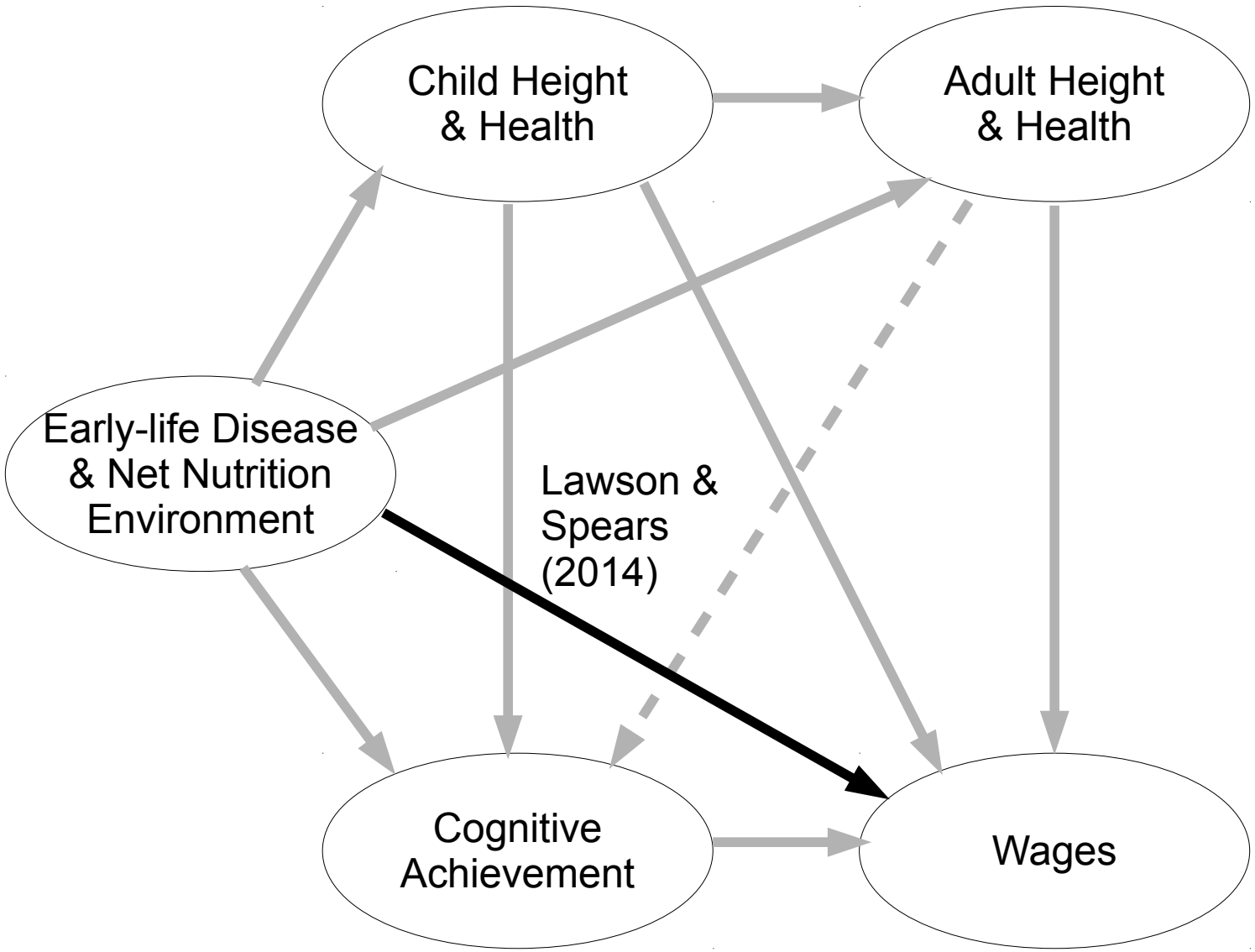


Effect of Disease & Nutrition Environment on Wages

- previous studies answering a version of this question:
  - Hoddinott et al (2008), INCAP nutrition intervention in Guatemala
  - Barreca (2010), malaria exposure in US south
  - Cutler et al (2010), malaria eradication program in India in 1950s (effect on consumption)
  - Almond, Currie & Herrmann (2012), association between post-neonatal mortality and mothers' outcomes in US

Our Question

- what is the effect of the early-life disease environment on adult wages in India?
  - important question in India, given prevalence of open defecation and stunting
  - we use IHDS data to examine how infant mortality rate and sanitation coverage experienced as a child are associated with adult wages
  - identification strategy: districts where improvements in disease environment have been steepest should be the districts where the wages of young workers are highest relative to the wages of old workers
- then simple calculation of fiscal effects of improvements in IMR/sanitation, and estimated welfare impacts of sanitation

Summary Statistics

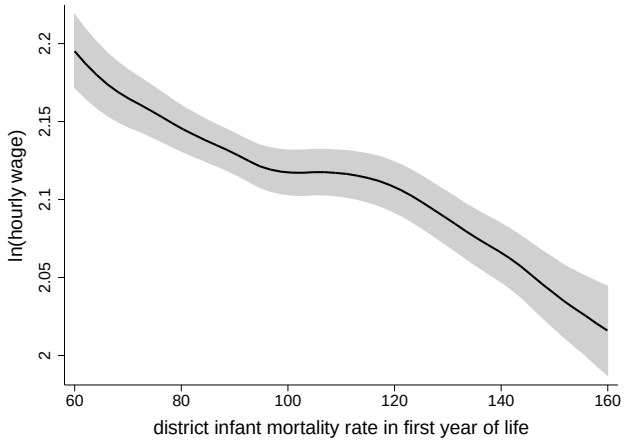
- individual data from 2004-05 India Human Development Survey
- historical district level data from Indian Census

Table: Summary Statistics

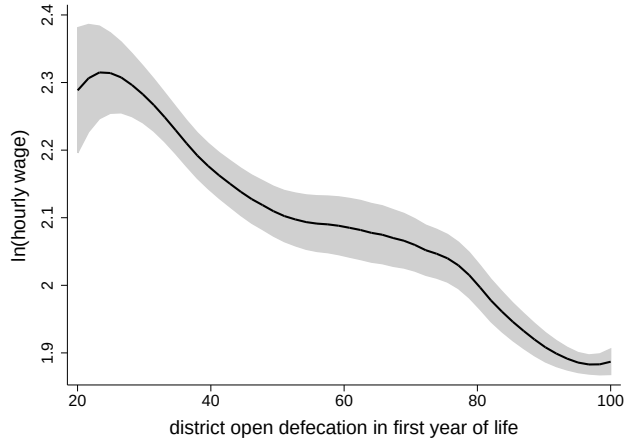
	Mean	SD	25th percentile	75th percentile
hourly wage (rupees)	10.43	9.11	5.71	12.00
log of hourly wage (rupees)	2.12	0.62	1.74	2.48
infant mortality rate in birth year	113.0	41.9	81.3	137.6
sanitation coverage in birth year	16.8	25.7	0.0	34.0
birth year	1979.4	4.9	1975	1983
age in survey	25.6	4.9	22	30
urban	0.3	0.5	0	1
n (adult men)	12,783			

Relationship Between IMR/Sanitation and Adult Wages

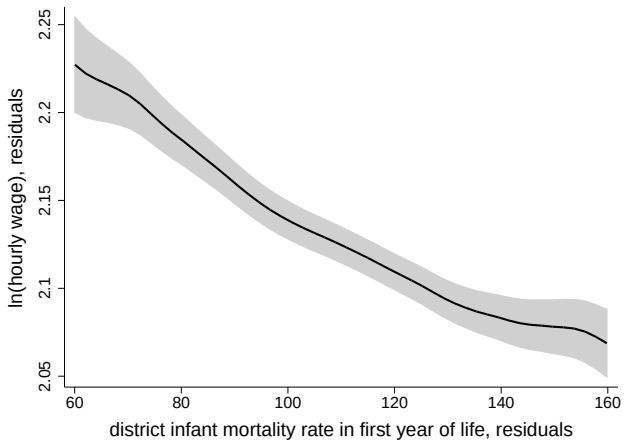
(a) effect of IMR, no controls



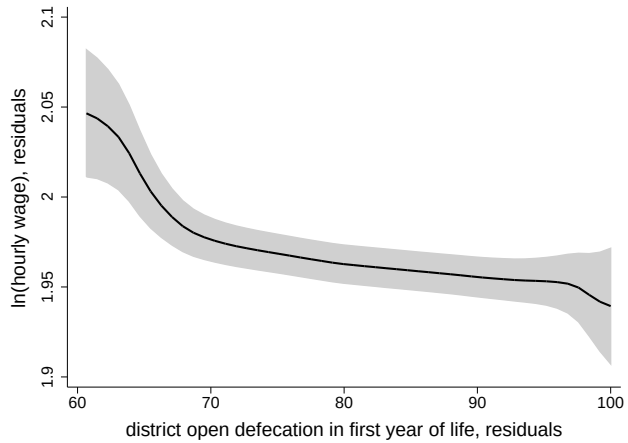
(b) effect of sanitation, no controls



(c) effect of IMR, with controls



(d) effect of sanitation, with controls



Regression Specification

- $\log(y_{tdsi}) = \beta h_{tds} + \gamma_t + \alpha_d + urban \times (\omega_s + g_i) + t_s + j_i + e_i$
- h stands for either IMR or sanitation coverage in year of birth
- t = time (year of birth), d = district, s = state, g = social group, j = job category, e = education category

IMR Regressions

Table: Regression of Wages on IMR

	(1)	(2)	(3)	(4)
Panel A: OLS				
IMR in birth year	-0.00174*	-0.00195*	-0.00166*	-0.00170*
	(0.000706)	(0.000796)	(0.000742)	(0.000699)
district fixed effects	✓	✓	✓	✓
year of birth fixed effects	✓	✓	✓	✓
state × urban fixed effects		✓	✓	✓
social group × urban indicators		✓	✓	✓
state-specific linear time trends		✓	✓	✓
job category fixed effects			✓	✓
education indicators				✓
n (adult men)	12,783	12,783	12,783	12,783

p values: $\dagger = 0.1, * = 0.05, ** = 0.01, *** = 0.001$. Standard errors clustered at the district level.

IMR Regressions

Table: Regression of Wages on IMR

	(1)	(2)	(3)	(4)
Panel B: IV (linearly interpolated IMR instrumented with log interpolated IMR)				
IMR in birth year	-0.00166**	-0.00167*	-0.00139*	-0.00156*
	(0.000597)	(0.000718)	(0.000696)	(0.000673)
district fixed effects	✓	✓	✓	✓
year of birth fixed effects	✓	✓	✓	✓
state × urban fixed effects		✓	✓	✓
social group × urban indicators		✓	✓	✓
state-specific linear time trends		✓	✓	✓
job category fixed effects			✓	✓
education indicators				✓
n (adult men)	12,783	12,783	12,783	12,783

p values: $\dagger = 0.1, * = 0.05, ** = 0.01, *** = 0.001$. Standard errors clustered at the district level.

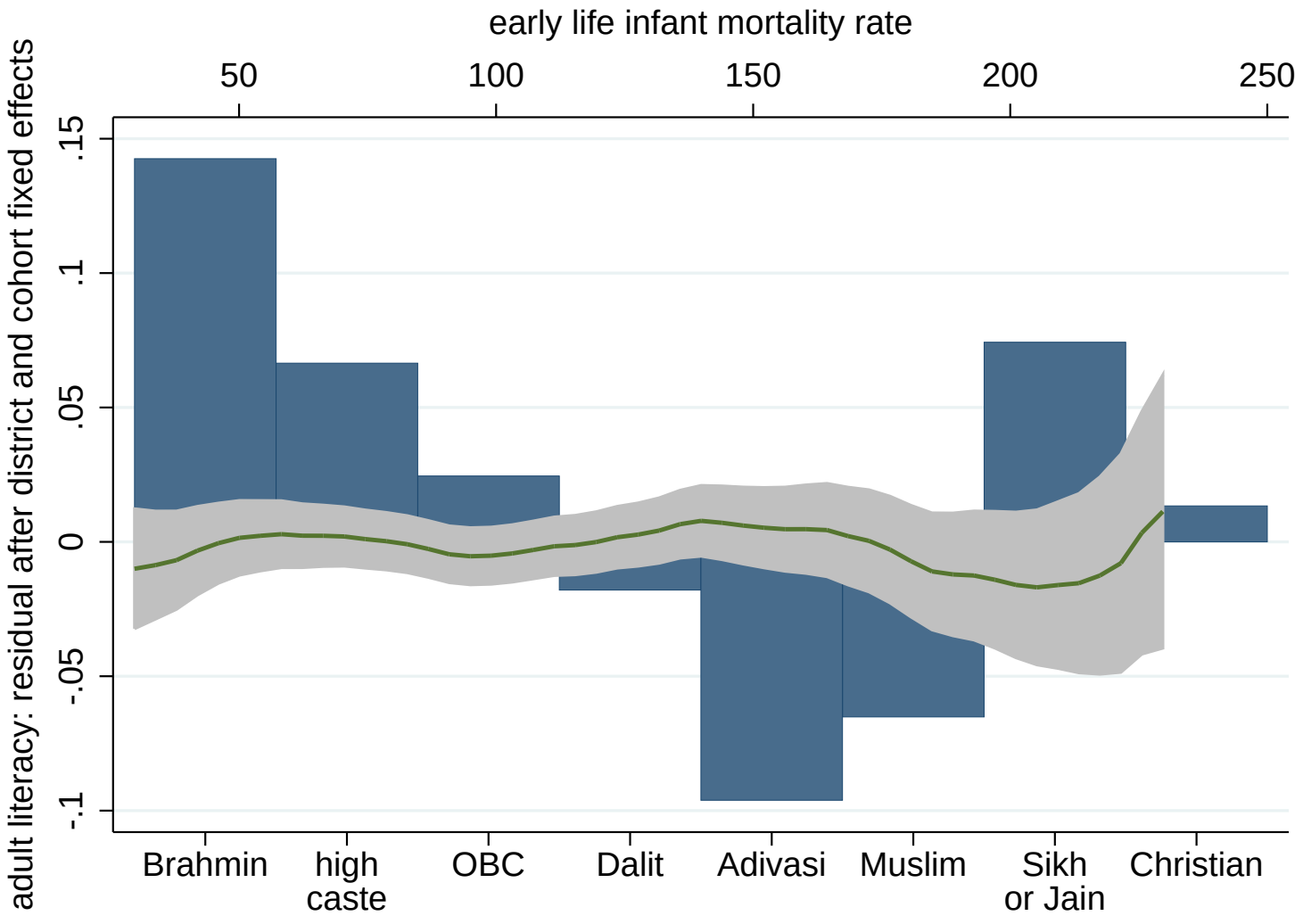
Sanitation Regressions

Table: Regression of Wages on Sanitation Coverage

	(1)	(2)	(3)	(4)	(5)
sanitation in birth year	0.00296***	0.00296	0.00181***	0.00322†	0.00286†
	(0.000509)	(0.001611)	(0.000509)	(0.00169)	(0.00169)
district fixed effects	✓	✓	✓	✓	✓
year of birth fixed effects	✓	✓	✓	✓	✓
state $\times$ urban fixed effects		✓		✓	✓
state-specific linear time trends		✓		✓	✓
social group $\times$urban indicators		✓		✓	✓
job category fixed effects			✓	✓	✓
education indicators					$F_{16,322} = 5.98$ ($p < 0.001$)
n (adult men)	6,134	6,134	6,134	6,134	6,134

p values: $\dagger = 0.1, * = 0.05, ** = 0.01, *** = 0.001$. Standard errors clustered at the district level.

Why Might Controlling for Education Make So Little Difference?



Schooling & Literacy

Table: Regressions of Schooling & Literacy on IMR & Sanitation

	(1) schooling	(2) schooling	(3) literacy	(4) literacy
IMR in birth year	0.00175		0.00057	
	(0.00508)		(0.00048)	
sanitation in birth year		0.0215		0.00102
		(0.0154)		(0.00148)
district fixed effects	✓	✓	✓	✓
year of birth fixed effects	✓	✓	✓	✓
n (adult men)	12,718	6,134	12,747	6,142

p values: $\dagger = 0.1, * = 0.05, ** = 0.01, *** = 0.001$. Standard errors clustered at the district level.

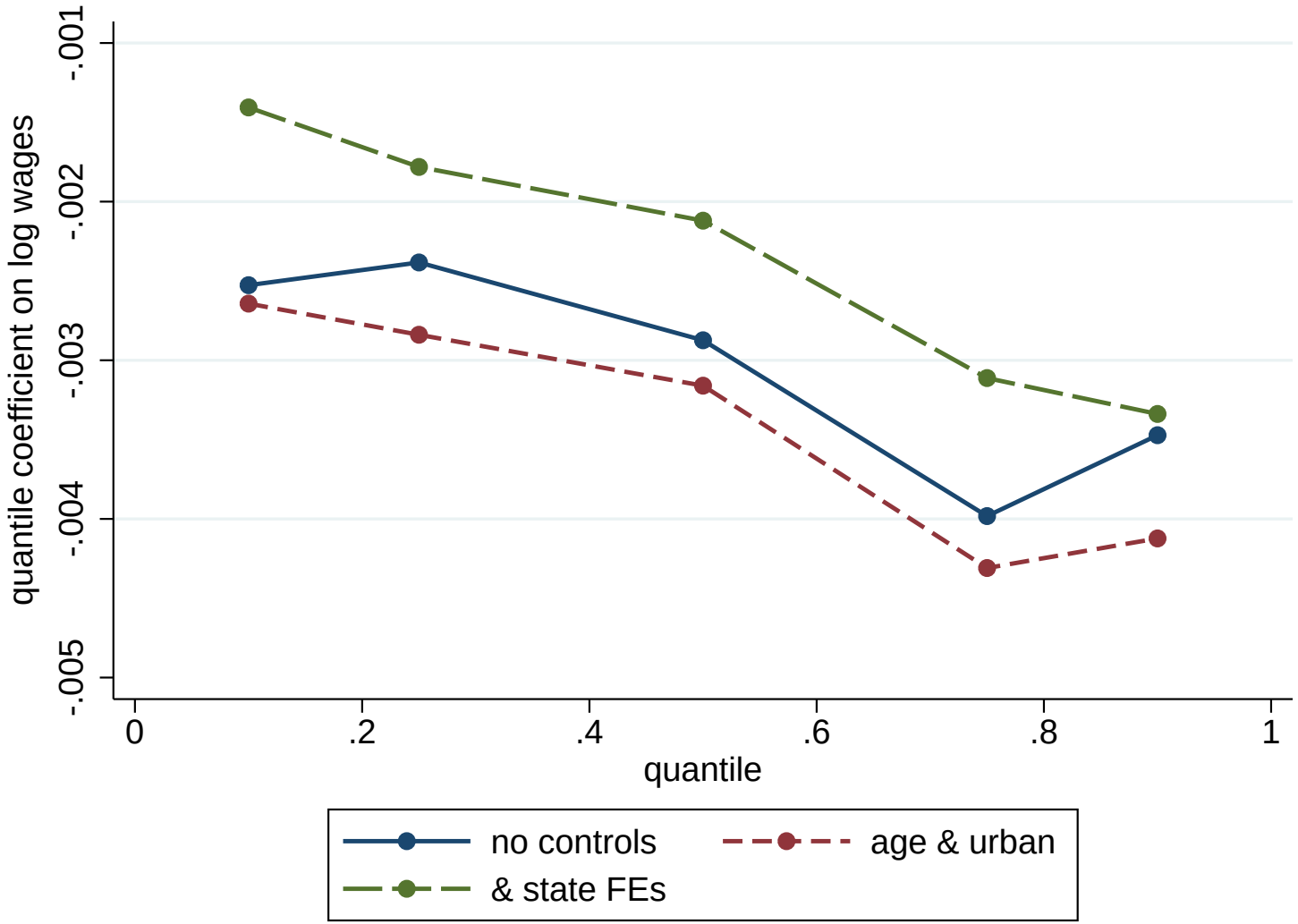
Consumption vs. Hourly Wages

Table: Comparing Coefficients for Wages and Consumption

	(1)	(2)	(3)	(4)
dependent variable:	hourly wage	consumption	consumption	consumption
sample:	full	full	main earner	not main
IMR in birth year	-0.00195*	-0.00152*	-0.00212*	0.000314
	(0.000796)	(0.000646)	(0.000820)	(0.000983)
district fixed effects	✓	✓	✓	✓
year of birth fixed effects	✓	✓	✓	✓
state × urban fixed effects	✓	✓	✓	✓
social group ×urban indicators	✓	✓	✓	✓
state-specific linear time trends	✓	✓	✓	✓
n (adult men)	12,783	12,716	8,312	4,404

p values: $\dagger = 0.1, * = 0.05, ** = 0.01, *** = 0.001$. Standard errors clustered at the district level.

Quantile Regressions of Log Wages



Fiscal Effects

- if investments to improve sanitation and/or lower infant mortality raise wages and therefore consumption, they will lead to increases in the government's tax revenues
- therefore, follow-up question: what will be the net fiscal impact?
- consider an investment costing c dollars today, but generating income gains of g_t percent at future dates
  - if government cares only about effect on net budget surplus, they should undertake the investment if the gain in tax revenues T, discounted appropriately ($\delta = \frac{1}{1+r}$), is greater than c:
  - invest if $c < \sum_{t=t_0}^{t_1} \delta^t \left[T((1+g_t)y_t) - T(y_t)\right]$

Estimated Fiscal Effects

- our preferred estimates indicate:
  - 10 point reduction in IMR (1% point) leads to wage increase of 1.74%
  - 10% point improvement in sanitation coverage raises wages by 2.96%
- thus, the simplest calculation of fiscal benefits would be to assume that government tax revenues increase by the same percent
  - given quantile regressions, this is likely conservative, as gains appear larger at higher incomes

Estimated Fiscal Effects

- government revenues from income taxes, excise duties and service tax were approximately 5.11 trillion rupees ($82.3 billion US) in 2012-13
- assuming 40 years of working life, $2.06 billion from each year-of-birth cohort, and revenue gains per year are $36 million and $61 million
- 3.85% real interest rate (8.9% minus inflation of 5.05%)
- also ignore economic growth, which could seriously understate the effect

Estimated Fiscal Effects

- now add up discounted revenue gains into the future
  - for 1% point reduction in IMR for all generations starting from today
  - and for complete elimination of open defecation today

Fiscal Effects of 1% Point Reduction in IMR

- start counting fiscal gains 18 years from now, phasing in year-of-birth cohorts one by one until complete after 57 years, run until 100 years from now
- per-year revenue increase eventually reaches $1.43 billion
- present value of revenue gains are $9.43 billion

Fiscal Effects of Elimination of Open Defecation

- again, starting counting fiscal gains 18 years from now, but now assume linear gains from elimination of open defecation
- allow for declining trend: open defecation rate 53.1% in 2011, but declining at average of 1.05% per year over previous decade, so assume this continues linearly without any intervention and open defecation would thus be eliminated in 2062
- revenue gains start at $323 million 18 years from now, peak at $4.25 billion in 43 years
- present value of revenue gains are $52.23 billion, or about $399 per household that defecates in the open

Analysis of Fiscal Effects

- these gains are substantial, and indicate that investments in reducing or eliminating open defecation that cost less than $399 per household that stops defecating in the open would not have any net cost to the government
- and we ignore other fiscal gains from reduced health care expenditures, calorie requirements, etc.

Welfare Effects

- we can also estimate the effects of investments in sanitation on overall well-being (through income and consumption)
- assume individuals receive disutility $d \sim F(d)$ from latrine use, so the fraction $L = F(0)$ use a latrine
- but government can, for cost c per unit, shift L upwards (educate people to receive higher direct utility from using a latrine)
    - ignore welfare gains from changing preferences of inframarginal latrine users

Welfare Effects

- assuming constant income/consumption, let $\sum_d = \delta^{t_0} \frac{1-\delta^{t_1-t_0+1}}{1-\delta}$ and $V = \sum_d E[U]$
- the welfare gain can be approximated:
- $\frac{dV}{dL} = \sum_d E\left[MU[(1-t(y))\frac{dy}{dL} + E[t(y)\frac{dy}{dL}] - \frac{1}{\sum_d} c\right]$
- $\frac{dW}{dL} \equiv \frac{\frac{dV}{dL}}{E[MU]} = \sum_d \frac{E\left[MU(1-t(y))\frac{dy}{dL}\right]}{E[MU]} + \sum_d E\left[t(y)\frac{dY}{dL}\right] - c$

Estimated Welfare Effects

- in simplest version ignoring distributional effects, just add increase in after-tax wages to fiscal gains
- consider an investment costing $399 per household, i.e. perfectly offsetting fiscal gains; then, with per-capita income of $1219, 10% point reduction in open defecation raises wages by $36 per male worker per year
- tax revenue as % of GDP was 10.39% in 2011, and I use discount rates of 3.85%

Estimated Welfare Effects

- income gain for an individual born today would be $1830 in present value
- with male workforce of 240 million ("main workers" from 2001 Census), total income gains are $166.71 billion
- in future work we can examine robustness to distributional effects, and use estimated effects of sanitation on consumption

Conclusion

- we set out to answer the question of the effect of early-life sanitation/disease environment on adult wages
- lower IMR and better sanitation are associated with significantly higher adult wages
- these wage gains translate into significant fiscal impacts
- eliminating open defecation today would generate additional government revenues of $52 billion in present value, and further income gains of as much as $167 billion

THE END